



U.S. Department of Energy
Energy Efficiency and Renewable Energy

SuperBoiler Update

American Boiler Manufacturers Association
Manufacturers Conference
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Bob Gemmer
Technology Manager
Industrial Technologies Program
Energy Efficiency and Renewable Energy (EERE)
U.S. Department of Energy



ITP is enhancing national energy security, competitiveness, and environmental quality by transforming the way U.S. industry uses energy.



Partnerships



Collaborative
research &
development



Delivery of
energy-efficient
practices and
technologies

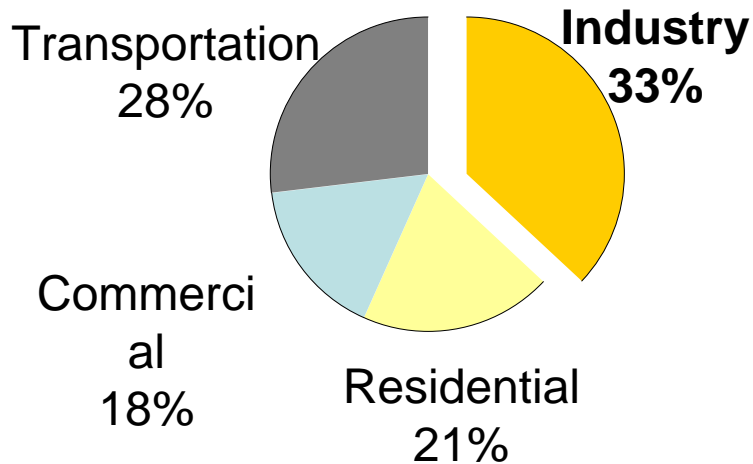
Core activities reduce industrial energy intensity through applied R&D and technology delivery.



Industry consumes about one-third of U.S. energy and represents significant opportunities to save energy.

2004 Energy Use*

100.3 Quads
(Quadrillion Btu)



*Includes electricity losses

U.S. industry represents:

- 37% of U.S. natural gas demand
- 29% of U.S. electricity demand
- 30% of U.S. greenhouse gas emissions
- More energy use than any other G8 nation

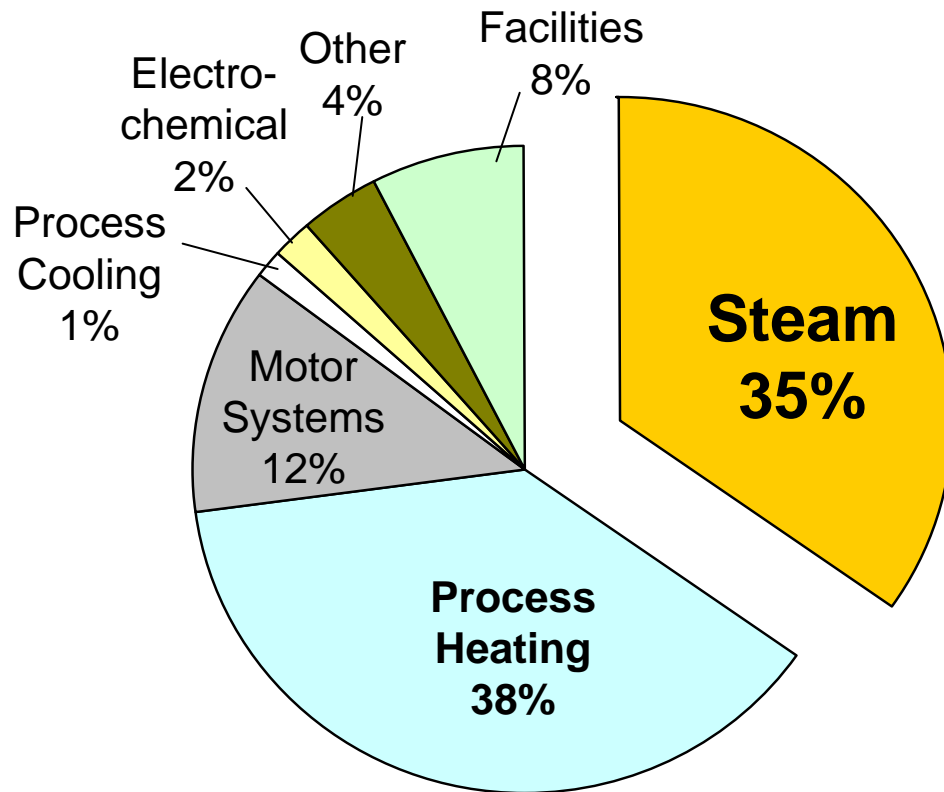
Industry spent \$150 billion in 2003 on purchased energy.



Industrial Boilers and Steam Use



Manufacturing and Mining Energy End Use



- **Steam Use: ~6,200 trillion Btu/yr**
- **Steam Onsite Losses: 2,800 Tbtu/yr**
 - **Generation ~ 1,200 Tbtu/yr**
 - **Distribution ~ 1,000 Tbtu/yr**
 - **Conversion ~ 600 Tbtu/yr**

Note: Does not include offsite losses



Age of Boilers

- Total sales of new boilers over the last 40 years are smaller than the current boiler inventory. This suggests that many boilers used today are more than 40 years old
- Approximately 7% of boiler capacity is less than 10 years old

2005 DOE Report: “Characterization of the U.S. Industrial Commercial Boiler Population”



Target Opportunity: Steam Generation



Big numbers

- Boiler population
- Energy consumption
- Emissions

Aging Boiler Fleet Creates
Opportunities for New Technology!



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SuperBoiler Vision



Target – Steam Generation

Potential Impacts:

- ✓ Increase industrial package boiler efficiency from 75% to 95%
- ✓ Reduce emissions of SO_x, NO_x, and carbon oxides

Controls

- “Smart” system controls
- Modeling



System Engineering

- System integration approach
- Modeling to expedite overall design

Heat Production

- Fundamental R&D
- CFD Modeling
- “Smart” burners

**Energy Savings
of 1,049 TBtu in
2030**

Heat Transfer

- Innovative heat transfer concepts
- Modeling and materials

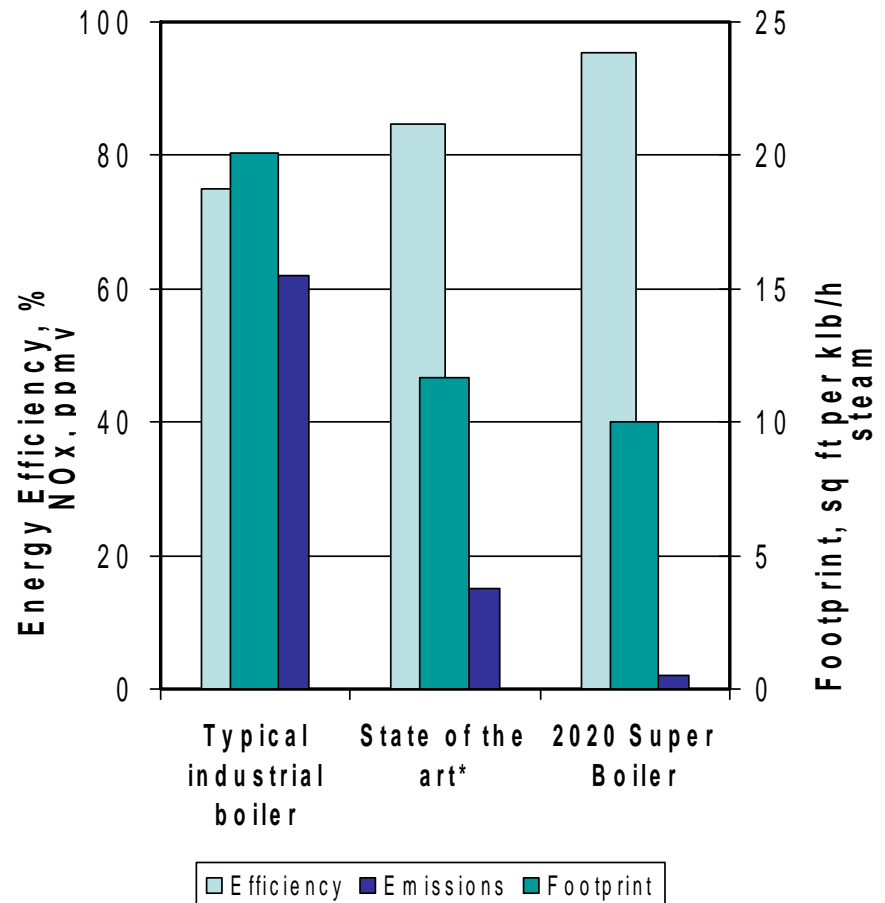
Heat Recovery

- Improved materials
- Innovative concepts for heat recovery



SuperBoiler?

- Not a bigger boiler but a **better** boiler!
 - Higher energy efficiency - more than 95% HHV
 - Super-low emissions - down to 2 ppm NOx and 5 ppm CO
 - Smaller and lighter - reduce size and weight by 50 percent
 - Competitive performance
 - Cost-effective



* Not all in the same boiler



First Generation SuperBoiler



1st Generation SuperBoiler Concept

- Evaluate four fundamental components in modern boilers
 - Combustion
 - Heat Transfer
 - Heat Recovery
 - Control
- R&D focus
 - Advancements in all 4 boiler components
 - System integration
 - Evaluate a near-term product design that “meet” the RFP goals



Potential Benefits of 1st Generation SuperBoiler

- 499,900,000 MMBtu/year energy savings
- \$2 billion/year fuel cost savings
- 18,386,000 ton/year CO₂
- 580,700 ton/year CO
- 205,600 ton/year NO_x
- ***Compelling economic benefits to accelerate replacement of aging boilers***



First Generation SuperBoiler Project

Project Description:

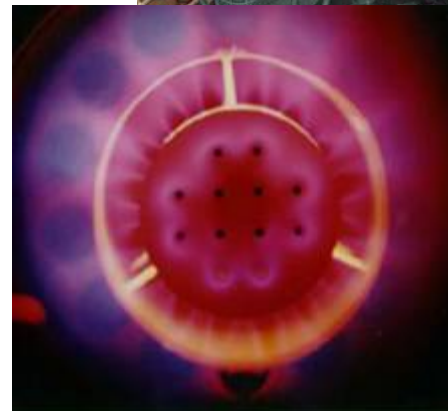
- Gas-fired firedtube boiler using innovative concepts in burner, heat transfer, heat recovery & control
- Develop and test a prototype at industrial host site
- Meet aggressive performance targets
- Partnered with Cleaver-Brooks

Technical Objectives

- 94% efficiency (from 70-83%)
- <5 ppm NO_x (from 30-100 ppm)

Funding

- \$2,600,000 -- DOE
- \$3,500,000 – industry cost share





Where are We?

- Lab testing Complete
 - Optimized combustion performance
 - Validated computer models for scale-up
 - Optimized heat recovery system performance
 - Optimized control strategy
- Field demonstration
 - First field demonstration at a site in Alabama complete
 - Single stage combustion design with transport membrane condenser to recover latent heat
 - Over 6,000 hours of operation with no significant problems
 - Currently installing dual stage combustion design at a fruit processing plant in Ontario, California
 - Planning underway to demonstrate retrofit of transport membrane condenser
- Commercialization (Role of Private Sector)
 - Introduce into commercial and light industrial market



SuperBoiler

Next Steps



SuperBoiler Vision – Next Steps

- August 2004 Workshop on Ultra-High Efficiency Industrial Steam Generation R&D Opportunities
- FY 2005 Solicitation Objectives:
 - Thermal efficiency greater than 94% (HHV)
 - NO_x emissions below 2 vppm
 - CO emissions below 2 vppm
 - VOC emissions below 1 vppm
 - Capable of operating on multiple fuels
 - ***Capable of producing high temperature/high pressure steam (greater than 1500°F/1500 psig)***
 - System weight and footprint 50% of currently available boilers with comparable performance



SuperBoiler Vision – Next Steps

- Solicitation for Second Generation Watertube SuperBoiler closed April 14, 2005
- Three proposals selected for funding
 - Babcock and Wilcox
 - Gas Technology Institute
 - Research Engineering Incorporated
- Research delayed due to elimination of Combustion budget in 2006
- Two of three projects restarted in 2007
 - Gas Technology Institute
 - Research Engineering Incorporated
- Two phases:
 - Phase I
 - Up to two years
 - Preliminary design and development
 - Phase II (Following down select)
 - Prototype development and field trial



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Questions?



Resources for Your Plant and Company

- Energy analysis software tools
- Case studies and information
- Energy efficiency training for plant staff
- Qualified specialists
- DOE-supported energy assessments

Call: 877-337-3463

**Websites: www.eere.energy.gov/combustion
www.eere.energy.gov/bestpractices
www.energysavers.gov/industry**



Industrial Energy Savers Website

- 20 Best Ways to Save Energy Now
- Learn How Others Have Saved
- Develop an Action Plan
- Access the National IAC Database

Energy Savers - Industry Plant Managers & Engineers - Microsoft Internet Explorer

Address: <http://www.eere.energy.gov/consumerinfo/industry/>

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Energy Efficiency and Renewable Energy *Bringing you a prosperous future where energy is clean, abundant, reliable and affordable.*

Energy Savers *A consumer guide to energy efficiency and renewable energy*

Home Improvements | Heat & Cool | Buy Clean Electricity | Make Clean Electricity | Buy Vehicles | Information Resources | Home

Industry Plant Managers & Engineers

20 Ways to Save Energy Now
Learn More
Develop an Action Plan

**Boost the Bottom Line:
Lower your plant energy bills**

Reducing energy costs can be as easy as adjusting a dial. Get started today with simple, low- or no-cost steps to energy savings:

- [20 Ways to Save Energy Now](#) for quick and easy cost savings
- [Learn more](#) about
 - How other plants have achieved big savings
 - Tools and training you can use to identify savings opportunities
 - Assessments for your facility
 - Industry expertise available
- [Develop an action plan](#) to evaluate your best opportunities and start saving on natural gas, electricity, and fuel oil in your plant

Results of Plant Assessments

Saving Energy
[Learn more about energy use in U.S. industry](#)

BestPractices, a part of the U.S. Department of Energy's (DOE) Industrial Technologies Program, works with industry to identify immediate opportunities to boost plant-wide efficiency and energy savings.

www.energysavers.gov/industry